EPR Pool Liners

6.
6.0.

DESIGN OF POOL LINERS (EXCEPT IRWST)
SAFETY REQUIREMENTS

The safety requirements are presented in Chapter C.5.0. and specifically in Chapter C.3.5.0.4.4.4.

6.1.

ROLE OF THE LINER

The EPR pools are compartments for fuel storage and handling, etc. The pools are made watertight by a liner covering their concrete walls. The liner consists of metal panels welded onto anchors sealed into the concrete. It has no structural resistance capability. The liner is required to be watertight in order to: ensure the fuel remains under water prevent damage to the concrete structure ensure radiological protection (containment of radioactivity)

6.2.

LINER DESIGN BASIS

When full, the pools contain demineralised borated water. Any leaking water must be collected, detected and the leak repaired. The liner must be able to be decontaminated and must be resistant to corrosion. The equipment located in the pools is attached to plates anchored directly to the concrete wall so that no strain is placed on the liner. The requirements for leak resistance of the liner must be met for the various load assumptions defined in the ETC-C.

6.2.1.

Requirements during operation

To ensure the leak resistance of the doors (autoclave doors) of the fuel building spent fuel pool, the water level in this compartment must always be higher than that of adjacent compartments.

6.2.2.

Temperature

The design temperature of pools is 80°C. The integrity of the spent fuel pool (see 6.3.2 within Sub-chapter I.1) and its metal liner must be ensured for an accident temperature of 100°C until the cooling system is restarted.

6.3.
6.3.1.

DESCRIPTION OF THE POOLS
Reactor building

The reactor building pool is located in the containment above the reactor vessel and comprises four compartments: the reactor compartment, which is located directly above the reactor vessel the reactor internals compartment, which is associated with the reactor compartment (same pit) the transfer compartment, which is used to transfer fuel between the reactor building and the fuel building (the transfer tube connecting the transfer compartment of the two buildings is an integral part of this compartment) the equipment storage compartment, which is located next to the transfer compartment, between the reactor internals compartment and the containment.

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These four compartments can be isolated from one another by removable sluice gates with the following allowed configurations: sluice gate between the reactor compartment and the reactor internals compartment: open during normal operation and closed for occasional operations such as repairs to the reactor sluice gate between the reactor internals compartment and the transfer compartment: open during normal operation sluice gate between the reactor internals compartment and the equipment storage compartment: closed during normal operation

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6.3.2.

Fuel building

The spent fuel storage pool is located in the fuel building and is divided into three compartments: the spent fuel pool containing the spent fuel assemblies for deactivation. (Also used for buffer storage at each unloading/reloading campaign.) the transfer compartment - part of which is the transfer duct which transfers and then stores the fuel from the reactor building the loading pit, which is the dedicated compartment for loading and unloading the fuel via a trap in the bottom of the pit. The spent fuel assemblies and the spent fuel rods are loaded into lead casks before being transported off the site.

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These three compartments can be isolated from one another using doors, as follows: isolation between the spent fuel pool and the transfer compartment is achieved using a revolving door near the spent fuel pool in addition to a sluice gate. These devices are closed during normal operation.

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isolation between the spent fuel pool and the loading pit is achieved with a door identical to that described above. It is also closed during normal operation. Additional isolation may be achieved using a sluice gate inserted between the two compartments in the guide rails. isolation between the transfer compartments in the reactor building and those in the fuel building, in the transfer duct, is achieved using a plug on the reactor building side and an isolation valve on the fuel building side. This plug is closed during normal operation. N.B.: In the finalised design, the plug may be replaced by a valve identical to the one in the fuel building.

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6.4.
6.4.1.

CHARACTERISTICS OF EQUIPMENT
Pool liners

The metal panels forming the watertight liner are austenitic stainless steel sheets free of molybdenum, the characteristics of which are described in the ETC-C. The metal panels are welded onto anchors set into the structural concrete. These anchors, vertical and horizontal, are laid out on an even mesh pattern. The bottom of the loading pit is made from a one-piece metal plate. In all other cases, the liner comprises a series of metal plates welded to the anchors. The top of the duct for transfer between the reactor building and the fuel building is covered with metal panels anchored using the same method as for the vertical walls and bottoms of the compartments.

6.4.2.

Racks for storage and attachment of equipment

The equipment located in the pools (fuel storage racks, stands for storing vessel internals and other equipment) is attached di rectly to anchoring plates, which in turn are anchored directly into the structural concrete, so that no direct stress is place d on the liner. The liner is welded on to these plates.

6.4.3.

Piping penetrating the pool walls

The connection between pipes entering pools and the liner is such that no additional stress is placed on the watertight liner.

6.4.4.

Leak detection and drainage

A leak detection, location and drainage system is installed in the area of the welds, behind the watertight liner. The leak dra inage channels are installed along the anchoring mesh of the metal liner, on the vertical walls and the bottom of the pool. Any leaks are collected from each panel; each drain can be isolated in order to locate the leak. A flow meter is installed on each header inlet. The drains are equipped with isolation valves to control loss of water from the pool in the event of a leak.

With the deactivation compartment filled with water, a radiography system tests 100% of the welds on the walls of the fuel buil ding pool.

6.4.5.

Lighting

The pools are equipped with an interior lighting system. The lighting is waterproof and protected from corrosion.

6.5.
6.5.1.

SAFETY ANALYSIS
Compliance with regulations

The design of the pools complies with the national regulations in force.

6.5.2.

Other regulatory requirements: specific EPR texts

The pool liners comply with the requirements given in the ETC-C.

6.5.3.

Compliance with functional criteria regarding leak resistance

Any leak in the pool liner is detected by measuring water flow at the collection system outlet so that the damaged panel can be located. If a serious leak occurs, loss of water from the pool can be stopped using isolation valves located on the drainage c hannels. Water losses are thus always minimal.

6.5.4. Compliance with design requirements regarding internal and external hazards
The pools are designed to resist earthquakes, in compliance with the ETC-C. This hazard is assessed taking into account the tem perature increase resulting from an earthquake, which may directly impact the leak resistance function. In the case of a spent fuel pool which is still filled with water, leak resistance is also ensured for loads associated with reference incidents and a ccidents and operating conditions involving multiple failures (RRC-A).

6.6.
6.6.1.

TESTING, INSPECTION AND MAINTENANCE
Operational testing

The design, construction and installation are validated by tests at various stages in the project before the plant is commissio ned. These tests are described in the ETC-C and are also mentioned in an inspection follow-up document.

6.6.2.

Periodic tests

The types of tests, their evaluation, frequency and the measuring device used are also defined in the inspection follow-up document. The main visual inspections of the metal liner are performed using an underwater camera.

6.6.3.

Maintenance and inspection

The metal liner of pools requires no preventive maintenance. The leak detection system is fitted on all anchors on the liner of compartments in the two pools. All leaks may be detected, located and repaired. For the deactivation compartment, still filled with water, a weld radiography system is fitted on the walls of the fuel building pool. Corrective maintenance concerns only welds and welded components of the pool liners. Temporary welds may be made when a leak is detected. This temporary welding is valid only until a permanent repair can be performed.